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SLIDING A BRIDGE GIRDER ACROSS A RIVER - SEE PAGE 441

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FAITH
in the
WHITE PRODUCT

If the installations of White Truck fleets in commercial service were expressed in terms of money, they would furnish impressive evidence of the faith large truck users have in White performance. The following figures show some of the large investments represented by individual fleets.

1 owner has invested over					$2,000,000
2 owners have invested between					1,000,000 and $2,000,000
5	"	"	"	"	500,000 and 1,000,000
6	"	"	"	"	300,000 and 500,000
15	"	"	"	"	200,000 and 300,000
41	"	"	"	"	100,000 and 200,000

These figures do not include any trucks owned by the United States or foreign governments

When the large user standardizes on White Trucks, acquiring more of them every year, he must *know* their operating merit. When he invests a quarter million, half a million, two to three millions, in White Fleets, he must have implicit faith in their investment value.

What safer example could be afforded the truck buyer who does not have a broad comparative experience of his own to guide him? Investment value in the case of a single truck depends upon earning power quite as much as in the case of a large fleet.

THE WHITE COMPANY
CLEVELAND

"For cigarette packages the fancy-colored paste-board box no longer seems to be the mode."

The Real Thing as sure as you live

Believe it or not—it's a fact.

That simple, soft foil Fatima package is today America's most fashionable package for cigarettes. Most fashionable because most widely used by those men who know "what's what" in smokes.

At the big hotels and clubs, at smart resorts such as Palm Beach and Atlantic City—even at Newport itself—the Fatima package now holds the prestige formerly held by the fancy, expensive paste-board box.

The reason for Fatima's popularity is "JUST ENOUGH TURKISH."

Instead of containing *too much* Turkish as do the expensive, straight Turkish cigarettes, Fatima contains *just enough* Turkish—just enough to *taste* right and just enough to leave a man *feeling* right, even when he smokes more than usual.

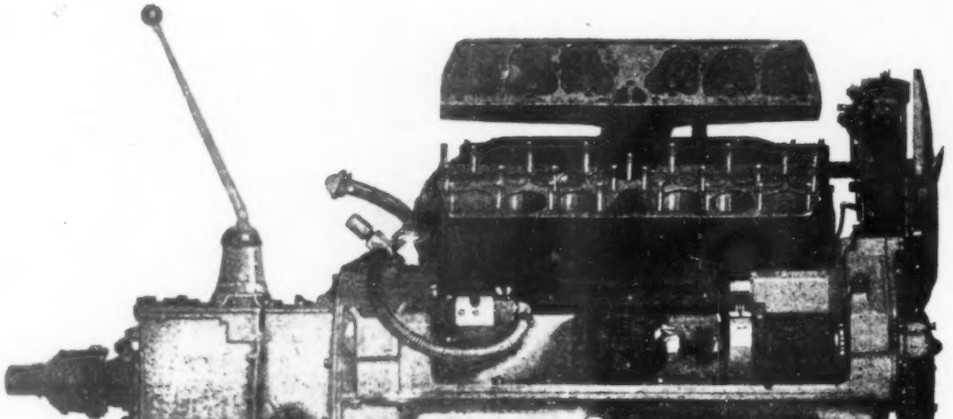
You, too, will be proud of Fatima's package as soon as you test Fatima's quality.

Liggett & Myers Tobacco Co.

FATIMA

A Sensible Cigarette

Simplicity and Accessibility, attributes of Twin-Six Engineering



MOTOR CAR SAFETY *depends on* RIGHT ENGINEERING

A STUDY of the causes of motor car mishaps will show that in nine cases out of ten they are as much the fault of the car as of the driver.

In planning for the safety of a man and his family, Packard Engineering never compromises with chance. Even if every one of the 6,000,000 motor car drivers in this country were always careful and thoughtful—there would still be accidents.

The greatest possible care will not help a man if his car fails.

Safety is the first and foremost consideration in Packard engineering. There is a sound, practical engineering reason for every factor of safety in the Packard car.

Consider the security afforded by the high reserve power of the Packard Twin-Six—the stored-up energy which responds instantly in an emergency, but costs nothing when it is not in use.

The Packard is the safest car in the world to handle in traffic. From less than two miles an hour on high, it will pick up in a few blocks to more than a mile a minute. Its perfect balance—its ease of control—makes it stop or start without effort.

Just as the Packard engine is built to deliver more power than ordinary needs call for, the Packard car is built to withstand more than ordinary strain. Yet the Packard requires no more power to run than many cars which compromise with strength to secure lightness.

Its weight is scientifically adjusted to its power. It stays on the road when lighter cars show a tendency to leave it.

To the man who has any regard at all for himself or his family, Packard safety is priceless.

The Packard people are transportation experts; they have more to tell you on this subject than any other organization in the world. You can ask them to discuss your car problem without obligation. It is to your interest and profit to do so.

"Ask the Man Who Owns One"

PACKARD MOTOR CAR COMPANY - - *Detroit*

SEVENTY-FIFTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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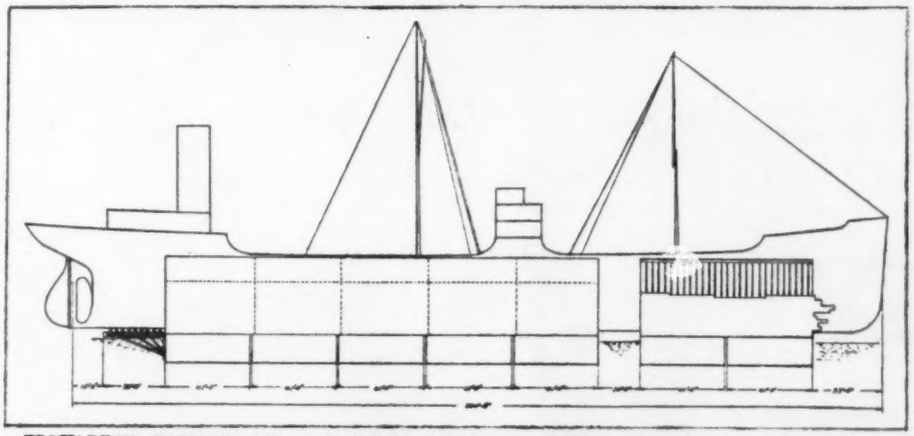
SETTING A DRY-DOCK TO WORK WHILE UNDER CONSTRUCTION

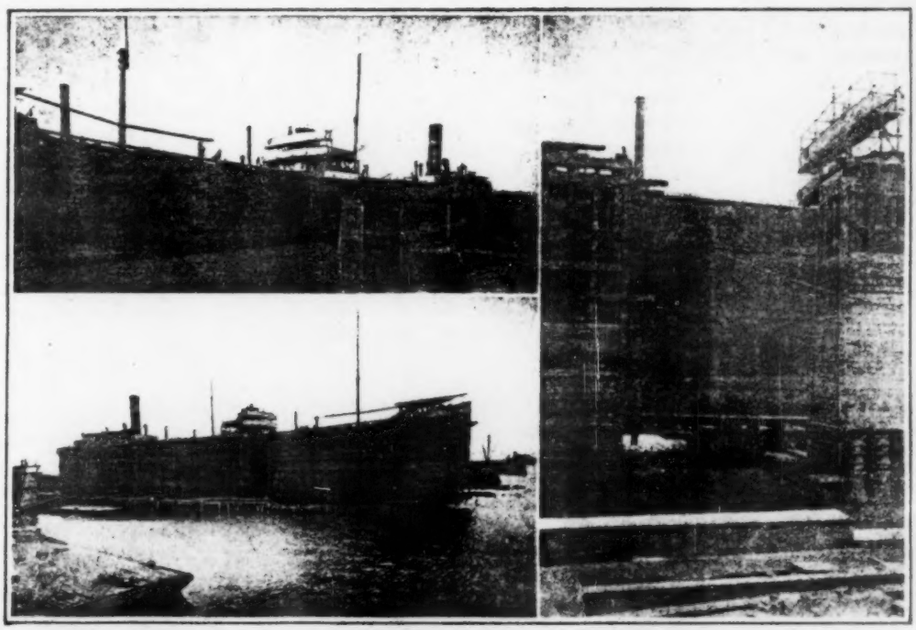
There is a serious shortage of dry-dock facilities in this country. We have built up a big merchant marine but means to keep this fleet in condition for service has not kept pace with the construction of the ships. Vessels are held for weeks in our harbors, awaiting their turns to put into the few dry-docks we have, for necessary renovations. During the war ships were kept in commission just as long as they would keep going. It was more important to move men and cargoes than to consider the life of the ship. When the war ended, in addition to normal demands our docking facilities were immediately swamped by the large number of long-neglected vessels that had to be put in dry-dock and brought to condition for service. In the emergency, some rather ingenious schemes were brought forth for attending to ships where dry-docking facilities were a bit weak.

Last May, for instance, the steamer "San Antonio" put into Mobile crippled. This vessel measures 390½ feet between perpendiculars and has a molded depth of 54 ft. 4 inches. There was no dry-dock at Mobile large enough to accomodate her but it happened that there was one under construction that would do the trick if only it were ready. This dock was being built in two sections of five pontoons each. The first had been completed, and it had a lifting capacity sufficient to take care of the San Antonio; but the section was only 240 feet long and there would have been such overhang at each end as would buckle the hull or strain the plates. The second section of the dock was, however, under way; its first two pontoons stood completed and work on their wings was under prosecution.



ELEVATION SHOWING THE SAN ANTONIO IN THE UNFINISHED DOCK, WITH SPACE BETWEEN THE TWO SECTIONS

This work was hastened; these wings were planked up to such a level that the pontoons could be safely sunk under the San Antonio and they were temporarily fitted with motors and pumps so that they could be used with the one complete section to support the vessel. The drawing shows how in this way the finished and unfinished sections were used to lift the San Antonio out of the water. A space of 20 feet was left between the two sections, allowing the ship to overhang 33 feet at the bow, and 15 feet at the stern. The repairs to the vessel, after she was thus docked, were completed far earlier than would otherwise have been possible. Moreover all the time while the ship was in the dock, work upon the unfinished section proceeded without a hitch! In this way the dock was able to earn money while not yet finished.



ABOVE: THE FINISHED SECTION OF THE FLOATING DRY-DOCK IN PLACE. BELOW: THE SAN ANTONIO IN THE DOCK, WITH WORK PROCEEDING SIMULTANEOUSLY UPON SHIP AND DOCK. RIGHT: THE TWENTY-FOOT GAP BETWEEN THE DOCK SECTIONS

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

HEAT TREATMENT IN GUN EROSION

There are few problems in the metallurgical and allied arts that have proved more puzzling to the investigator, or have received a more thorough investigation than that of the causes and cure of gun erosion. Perhaps the clearest and most complete discussion of this subject is that of Professor H. M. Howe, in a paper read at the latest meeting of the American Institute of Mining Engineers. He showed that erosion was the effect of heat treatment, due to the extreme high temperature of the powder gases. Any sudden heating and cooling, as we have long known, has the effect of hardening the surface of the bore. In a badly eroded gun the thickness of the hardened layer varies from one ten-thousandth of an inch at the muzzle to sixty-three ten-thousandths at the breech. Dr. Howe does not agree with the widely-held theory that this hardening is due to carburization; he believes it merely a result of heat treatment. There is too much carbon dioxide in the powder gases to permit carburization by the monixide.

Now we must remember the heating up of the liner is very rapid and lasts for a very small fraction of a second. An extremely fine film of the metal is suddenly raised above melting point; but the wave of heat starts flowing away to the exterior of the gun. The ferrite and cementite in this heated form merge and form austenite. As the heat passes out through the gun, the metal just beyond the thin fused film cools below the limit at which transition to austenite can occur. After the projectile has left the gun, the layer in which austenite has been formed cools again, and this cooling is accompanied by some reversion in the steel toward its original condition. This reversion of phase takes more time to effect than the change of the gun steel to austenite. Some of the latter therefore remains unaltered and, being rapidly chilled, is converted into martensite. On each successive discharge additional austenite is formed and in this way the thickness of the hardening layer increases progressively. The result is that the original tough face of the liner is replaced by a hard, brittle layer of martensite. Since the temperature gradient of this layer is very steep, the transformed metal is too brittle to adjust itself to the resulting differential expansions, and cracks are formed. On the lands of the rifling, these are generally transverse but in the grooves the principal cracks are longitudinal.

But why is the bore of the gun enlarged? What becomes of the metal that is worn away? Professor Howe agrees with the view we have long taken in this matter: that since a fine film of the interior surface is fused by the heat of the white-hot powder gases, the gases in rushing forward out of the gun, wipe off and carry away a certain amount of this film. The quantity is small enough at each discharge, but the accumulated wastage of many rounds serves gradually to enlarge the bore, especially towards the breech of the gun.

Although the nature and progressive effect of erosion are thus satisfactorily explained, there is not much prospect of any successful remedy being applied. The Krupp firm in Germany has from time to time asserted that they had produced a non-erodible steel; but samples cut from captured German guns show that while the metal is of good quality it contains no new ingredients.

THE AGE OF GLASS

Surely the Cinderella among materials of construction is glass. By day through countless windows that keep out wind and weather, the sun pours his rays into our dwellings, offices and factories. By night every lamp aglow spreads its light through a glass chimney, shade or bulb. It is through glass lenses that the lighthouse sends its warning beam, that ships may sail past shoal and reef in safety to port.

We are so accustomed to it all that we never realise how helpless we should be without this substance for which we know no general substitute. With its transparency for light it combines almost perfect impermeability for gases and very considerable strength, qualities indispensable in the construction of electric light bulbs and X-ray tubes. How many men owe their lives to the good offices of glass in accurate diagnosis with X-rays we must leave it to the surgeon to estimate.

Pliable, heat-resisting mica has advantages for certain uses; so has flexible celluloid. But these can never supplant glass for ordinary use. Even the one vice of glass - its extremely dangerous character when wrecked by accident - has, by modern art, been cut to a minimum, where special precautions are called for, by the familiar wire-net reinforcement, or the less familiar celluloid core.

Glass has given into man's hand the instrument to wage effective battle against that insidious enemy of his race - the elusive microbe, visible only under the high power of the microscope. Through glass lenses the astronomer peers into space that has no bottom, making observations from which he can predict the future with mathematical precision, and unravelling the mysteries of world creation and decay.

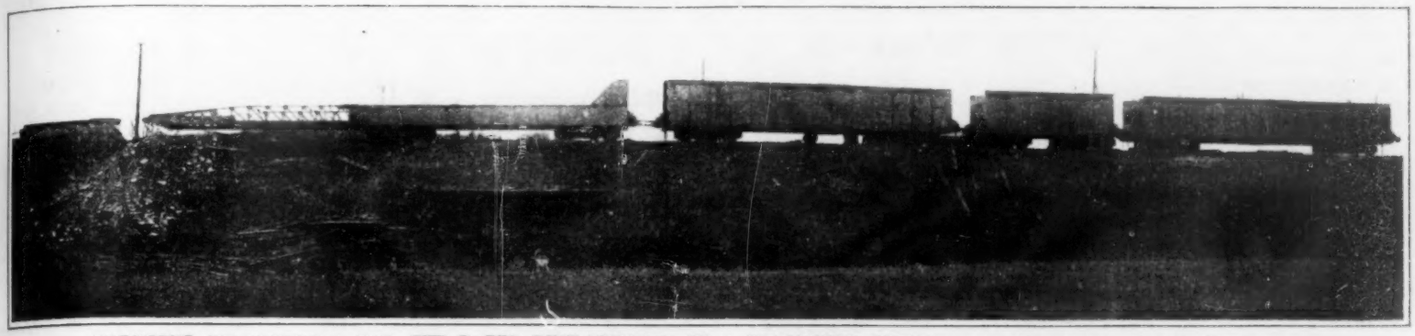
How many of us go through life bespectacled, and never give a thought in thankfulness to the good offices of Cinderella! Even the blind, in case of cataract, can be made to see by skillful removal of the eye's natural lens and susbtitution of one of this wonder substance.

Glass has made possible photography with its record of family histories, of the faces of our friends, of places visited and of the scenes of our holiday frolics.

The artistic possibilities of glass in other directions are probably not yet fully exploited. Church windows are one of the better known applications in this field; many other examples which might be mentioned will doubtless occur to the reader. Whatever we have achieved in these directions, that much more might still be done must have been vividly impressed on all who gazed in admiration at the Jewel Arch lately erected in New York to celebrate the home coming of our men from France.

If there is still a shadow of doubt as to the significance of glass in modern civilization, let us but estimate the daily attendance at the moving picture theaters, remembering that without the camera's glass eye the whole performance would be impossible. No glass, no movies.

Glass has been known from antiquity but its common use is comparatively recent. Ours has been spoken of as the age of steel. It might equally be pronounced the age of glass.



BRINGING UP MATERIAL FOR THE RAPID REPLACEMENT OF A DESTROYED BRIDGE ON THE PARIS-MULHAUSEN LINE

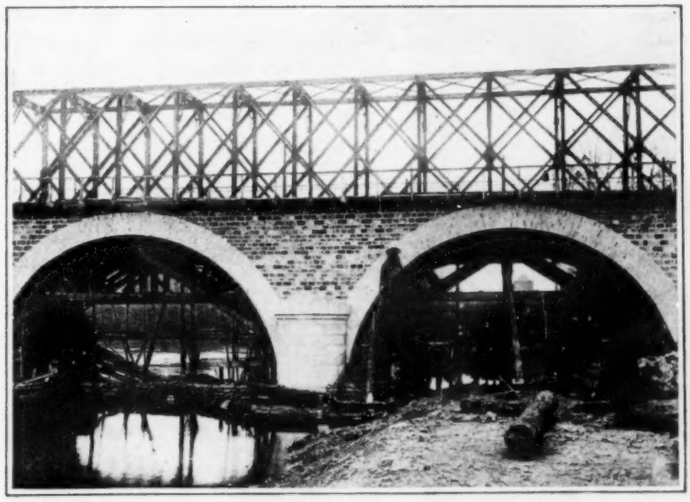
REBUILDING THE FRENCH RAILWAYS

It is estimated that the work of rebuilding the railway system of the devastated regions of France will attain the enormous total of 456 million dollars. This, it will be understood, is for purely railroad construction, taking no account of ruined villages, cities, factories, etc. Over half this sum must be spent in repairing track, buildings and equipment of the trunk lines. For local railways $83,000,000 will be needed and for canals $43,000,000 It will take $16,000,000 to make good the damage at maritime ports such as Dunkirk, and to repair the highways throughout the war zone will cost $64,000,000 more.

A determined effort is to be made, in the railroad reconstruction, to avoid all unnecessary features, and to standardize the material and equipment used. Three standards of rails are to be used: a 92-pound rail for standard-gage tracks with heavy traffic; a 72-pound rail for acerage use; and a 52-pound rail for lines of one meter gage. The rails are to be 18 meters long, or a multiple thereof.

The plans for new line and enlargement of existing systems which were being put through in 1914 are to be carried on to completion; but readjustments must be made to meet additional traffic due to the return of Alsace-Lorraine to France. It is interesting to note that besides the stations and work of a purely military character the army has constructed no less than 1030 miles of new line. The Minister of Public Works is earnestly engaged in repairing and replacing the local railroads, and 398 miles of track removed for military requirements at the front will be put back.

As for inland navigation by the canal system, 450 bridges must be reconstructed, 115 locks rebuilt or renovated, and 62 miles of canal bed are to be cleared of debris.



TEMPORARY STEEL SPAN ABOVE THE PERMANENT STONE ARCHES

The seaports most damaged were Dunkirk, Calais and Boulogne. The approximate cost of removal of wreckage and of repairs will be $1,600,000; and temporary berths for receiving coal which had to be imported on account of destruction of the French mines will involve an outlay of $14,000,000.

The highways of nineteen of the Departments of France were badly destroyed during the war. Of the National Highways 5592 miles and of other roads 59,650 miles must be repaired. The total cost of putting the transportation system of France is a shape where it will again serve adequately the needs of the country will be not less than $1,203,800,000.

The most important part of the work is that of repairing the many bridges. The number of these damaged reaches 1510. A good idea of both the emergency and the permanent work may be obtained from the photographs. Where the enemy had been driven back and it was imperative to get the lines rapidly into order, much use was made of piling, cribwork, and trestle bents to provide temporary crossings of the streams. This of course will give place to permanent steel structures.

Perhaps the most interesting of our views is that showing the method of launching a heavy plate-girder bridge across the gap intervening between piers. The span was assembled on flat cars and taken to the site, where the parts were coupled up to form the complete girder and this was then pushed forward across the opening. Supplementary girders of shallow depth attached to the end of the permanent girder secured an early lodgement on the far side.

THE "LAUNCHING" OF A READY-MADE BRIDGE OF STEEL SECTIONS

THE ROMANCE OF INVENTION - IV

CURTISS — HOLDER OF THE AIR RECORDS

By C. H. Claudy

If a man make a flying machine; and if it is the first of such devices to fly across the Atlantic Ocean; and if it flies higher and flies faster and climbs faster than any other machine: it would seem reasonable to consider this man as entitled to outstanding notice as an aerial inventor. Yet how many of those who read but newspapers know that NC-4 stands for Navy-Curtiss 4, and that the Curtiss Wasp has all airplane records: greatest speed, greatest ceiling, maximum climb?

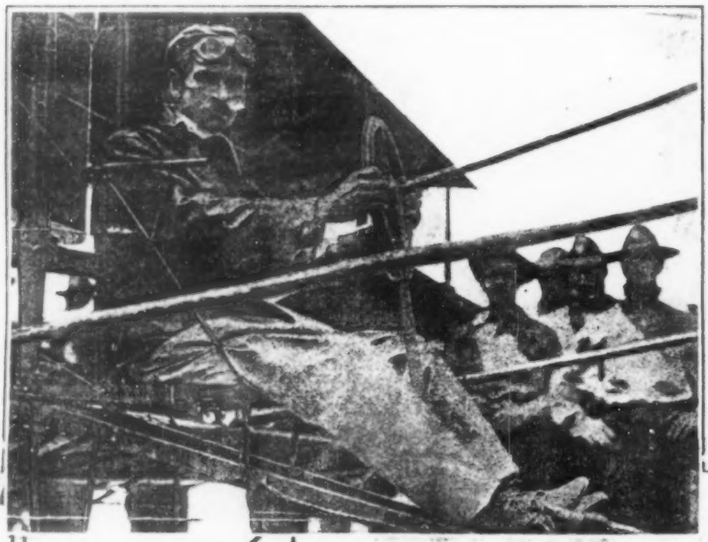
Glenn H. Curtiss has been interested in flying, not only from the earliest airplanes that flew, but even before they flew. Developing from a bicycle mechanic into a maker of motorcycles, dissatisfied with the engines to be had and so drifting into the manufacture of or small light engines, Curtiss it was to whom Capt. Thomas Baldwin turned when he wanted a motor to put into a cigar-shaped balloon for a dirigible. This was away back in 1904; and while his first aviation engine would undoubtedly lead Curtiss to smile now, were it suddenly put under his keen eyes, it was the forbear of that one with which Baldwin flew the first dirigible bought by the U. S. Government, and in the test flight of which Curtiss presided in person over the engine.

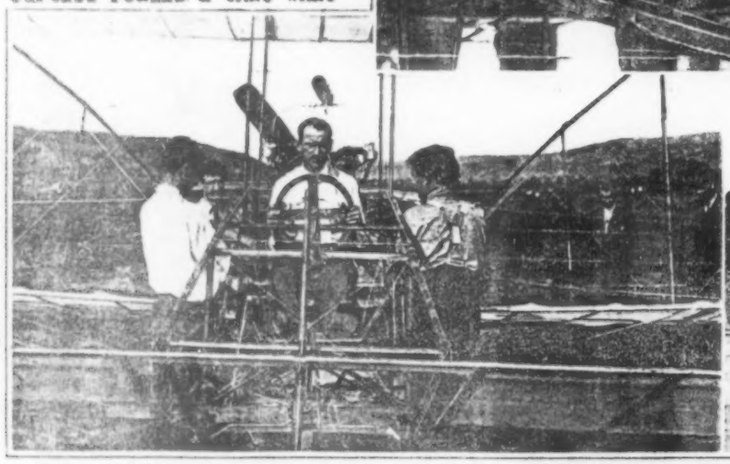
But the dirigible was slow and unwieldly; and while it was a decided drawing card at fairs and exhibitions, and as such a money-maker, Curtiss realized that what was really wanted was something that could be taken down for shipment and as readily put together to fly. So when Bell formed the Aerial Experiment Association and engaged Curtiss as engineer the young inventor was all enthusiasm and effort.

Now his motorcycle experience stood him in good stead. It takes a lot of nerve to drive a motorcycle at speed through a crowded field; and it took nerve to get up in a new and untried vehicle and hop through the air with at best a 50-50 chance that the hop would end in a tumble. But Curtiss thought little of the danger, and in 1908 at Hammondsport hopped, in the White Wing, the huge distance of one thousand feet, plus.

Came next the June Bug, the slender little plane which on July 4th, 1908 won the SCIENTIFIC AMERICAN trophy for the first public flight of one kilometer (5/8 mile). All this was the beginning of a series of aerial achievements that carried the name of Curtiss around the world on the lips of men and across the ocean in one of his flying boats. The Aeronautical Society ordered the first privately bought plane in America. Next came another SCIENTIFIC AMERICAN trophy for flying almost 25 miles (they didn't count inches this time) in forty-five minutes. At Rheims he beat Bleriot in a speed test, making the then unheard-of plane speed of 46.5 miles an hour. (The Wasp of today has made 136 miles with full load and Mr. Curtiss looks forward to much more than this. It is interesting to note that Curtiss holds the record of 137 miles per hour for a motorcycle; that his engines drove the motorboats Miss Miami and Miss Detroit III in their record runs, and that the speed record for over-the-water aircraft is his at 131 miles per hour with full load.

The aerial world now at his feet, he landed a real prize in the $10,000 put up by the New York World for a flight from Albany to New York. Then he began to go in for teaching others the art of flight; and his list of personally instructed students is almost that of American aviators who have pioneered in record-making. McCurdy, who first sent and received wireless from a plane; Hamilton, first to fly a Curtiss in the Gordon-Bennett race; Ely, who first landed on a battleship; Beachy, who first





Left: The June Bug, 1908, which won the SCIENTIFIC AMERICAN prize for the first public flight of one kilometer.

Right: The first hydroairplane, built at San Diego in 1911.

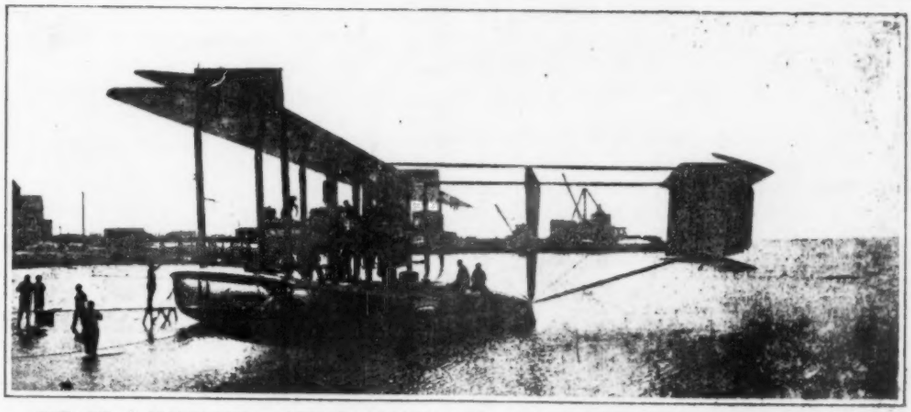
Top: The Hudson Flyer, with which Mr. Curtiss made the first flight from Albany to New York.

CURTISS IN SOME OF HIS MACHINES THAT HAVE MADE AIRPLANE HISTORY

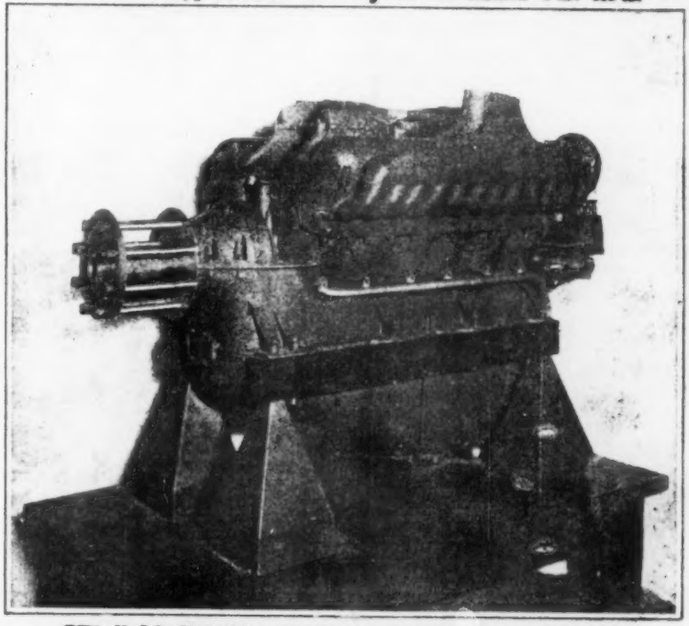
flew under the Niagara Bridge, and made the first altitude above 10000 feet; Ellyson, Towers, Richardson, Bellinger, first naval officers to fly over water together - and so on.

But Curtiss' mind was not satisfied to reap the fruits of invention, discovery and practical discovery. He liked to fly, and he enjoyed winning prizes; but the busy head was evolving something entirely new. The famed Albany-New York plane was a land plane with pontoons for water landing. Curtiss dreamed of a better thing -- a boat which would fly, rather than a flying machine that could land in the water. The hydroairplane was first, but the flying boat followed close on its heels, soon to be adopted by the Navy, and in time to earn for that arm of this nation the laurels of the first oceanic flight.

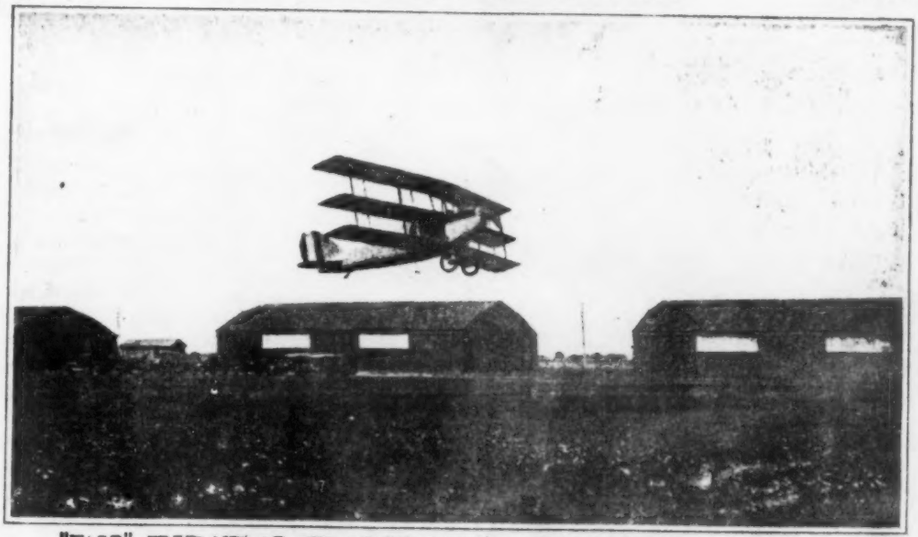
It is delightful to find Mr. Curtiss as modest and unassuming as if he had never so wrought that aerial honors are his in numbers greater than he can easily recall. He will not talk of early aviation without giving a lot of credit to others who were also pioneers. Wright, Langley and Chanute are names often on his lips. Indeed so loyal is he to work done by others that when C. M. Manley, in discussing the unfortunate Langley, insisted that the fabric of his former chief would fly, Curtiss said: "All right, bring it here, and we'll fly it." And after it was fitted with pontoons, Mr. Curtiss actually flew Langley's earliest man's-size machine over Lake Keuka, thus vindicating a man who gave his life for his convictions, as truly as though he had been killed in his machine.



THE NC-4 SEAPLANE. FIRST MACHINE TO FLY, IN STAGES, FROM AMERICA TO EUROPE. WEIGHT OF MACHINE LOADED, 28,000 POUNDS. HORSE-POWER (FOUR LIBERTIES), 1600. SPEED, 80-90 MILES PER HOUR



THE K-12 CURTISS ENGINE, A TWIN SIX, OF 400 HORSE-POWER, WEIGHING 728 POUNDS. THIS HAS DRIVEN THE WASP TYPE OF TRIPLANE, WITH FULL LOAD, AT A SPEED OF 160 MILES PER HOUR



"WASP" TRIPLANE AT THE START OF THE ALTITUDE TESTS. MAXIMUM HEIGHT ATTAINED, 34,610 FEET - THE WORLD'S RECORD. THIS MACHINE, WITH ITS 400-HORSE-POWER ENGINE, HAS CLIMBED 20,100 FEET IN 10 MINUTES

Mr. Curtiss, like all pioneers in a new field, pursued many of his experiments by the out-and-try method, as there was no other method available. While Langley and Chanute had done mathematical work with wings and air surfaces, experiment had revealed that theory and practice did not always agree. But Curtiss was by no means satisfied that experiment was the rapid path to perfection. He still believes, if not that the whole future of the art lies in the wind tunnel, at least that the bigger and better the wind tunnels, the more they are used, and the more competent the men in charge of them, just so the more quickly shall we approach the ultimate in form and surface of plane area, in fuselage and hull design and in propeller shape.

Hence, at his experimental plant in Garden City he has a very elaborate wind tunnel establishment, including not only what is credited with being the largest wind tunnel in the world, but one which has been freely and admiringly admitted to be the most complete and accurate of them all -- and this by those very men who designed and built the standard wind tunnels of Europe.

"Using this big wind tunnel," said Mr. Curtiss, "we are able to tell, in advance, within two miles, whatthe speed of any plane will be. We can design streamlines by mathematics and test our work as we go. We can produce new surfaces, shapes, cambers, angles; we can try new relationships

(Continued on page 448)

THE HEAVENS IN NOVEMBER, 1919

THE METCALF COMETS, AND SOME OTHERS

By Professor Henry Norris Russell, Ph. D.

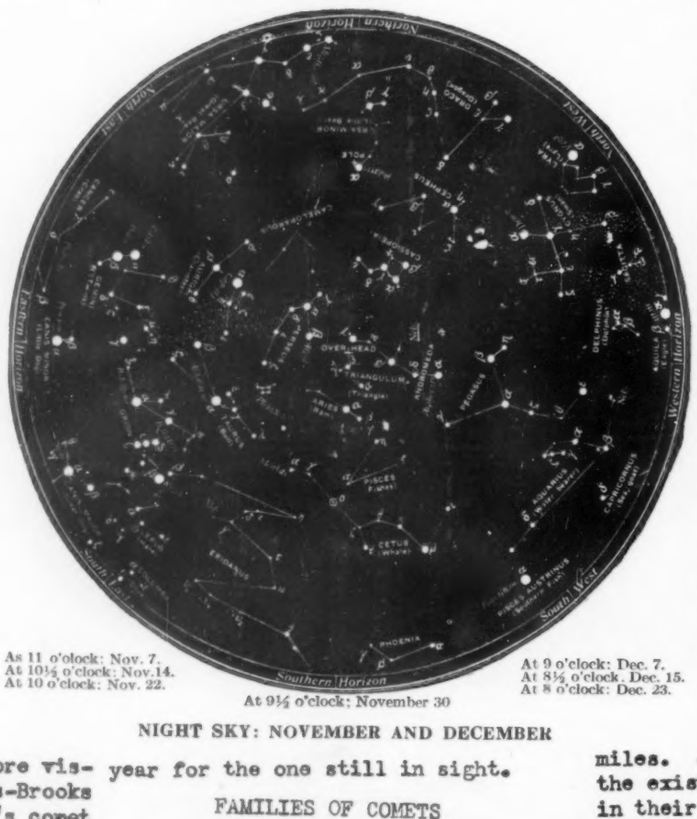
The comets whose discovery was told of last month are still in sight, but by no means conspicuous. The Brorsen-Metcalf comet, as it is now known after its two discoverers of 1847 and 1919, did not brighten up on approaching the sun to as great a degree as is often the case. At the moment of writing it is easily visible, with a field glass in the morning sky and it might be visible to the naked eye if the strong moon were out of the way; though it is hardly brighter than the fifth magnitude. It will be in the morning sky throughout November, moving southward and eastward and rising around two hours before the sun; but as it will continually be receding it will steadily grow fainter, and will soon fall below the limit of visibility for the unaided eye and probably for the field glass as well.

Metcalf's second comet will come a bit closer to the sun than indicated by the first rough orbit; perihelion will be reached on December 6th, at a distance of 104,000,000 miles. But as was apparent from the provisional calculations, it will not arrive anywhere near the earth, or be seen without a telescope. On November 2nd its predicted position is 16h 45m 48s R A and 7° 57' south declination, moving about 3m 15s eastward and 34' southward a day. It should lie between eighth and ninth magnitudes in brightness and set later than two hoursafter the sun.

THE PERIODIC COMETS

This return of the Brorsen comet adds a fifth member to the list of comets of fairly long period noted at two or more visits. The others are the Pons-Brooks comet of 1812 and 1884, Olber's comet of 1815 and 1887, Westphal's comet of 1852 and 1913, and last but not least Halley's comet, by far the most conspicuous as well as the most famed of all periodic comets, which has been observed at every one of 26 successive returns from B.C. 87 to A.D. 1910.

Two more comets are known, of about the same period -- De Vico's comet of 1847, figured at that time to have a period of some 75 years; and the second visitor of 1827, which, according to recent computations by the Japanese astronomer Ogura, has a period of about 64 years and must have returned unobserved some time around 1897. As the relatively few and inaccurate observations of this are satisfied with substantial accuracy by orbits of periods anywhere from 59 to 69 years, the accumulated margin leaves us in doubt whether the next return will be as early as 1945 or as late as 1965. The similar uncertainty in the case of De Vico's comet amounts to two or three years on either side of 1921 so that it is probable, when either one of these is seen again, it will masquerade as a new comet until calculation has an opportunity to show it is moving along the path of an old one. This is what happened in the case of the Pons-Brooks comet, and again this year for the one still in sight.



At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov.14.
At 10 o'clock: Nov. 22.
At 9½ o'clock: November 30
At 9 o'clock: Dec. 7.
At 8½ o'clock. Dec. 15.
At 8 o'clock: Dec. 23.

NIGHT SKY: NOVEMBER AND DECEMBER

FAMILIES OF COMETS

These seven comets, with periods in the range from 61 to 76 years, form a distinct group. The next shorter period is 40 years, and the next longer one 120 years. The statement is often made that this group belongs to Neptune's "family," a phrase that demands a word of explanation. One of the planets, Jupiter, unquestionably has a family of comets. Nearly forty have been found with periods lying in the range, five to nine years -- more than all with periods from 10 to 1000 years. The explanation of this gregariousness is not far to seek.

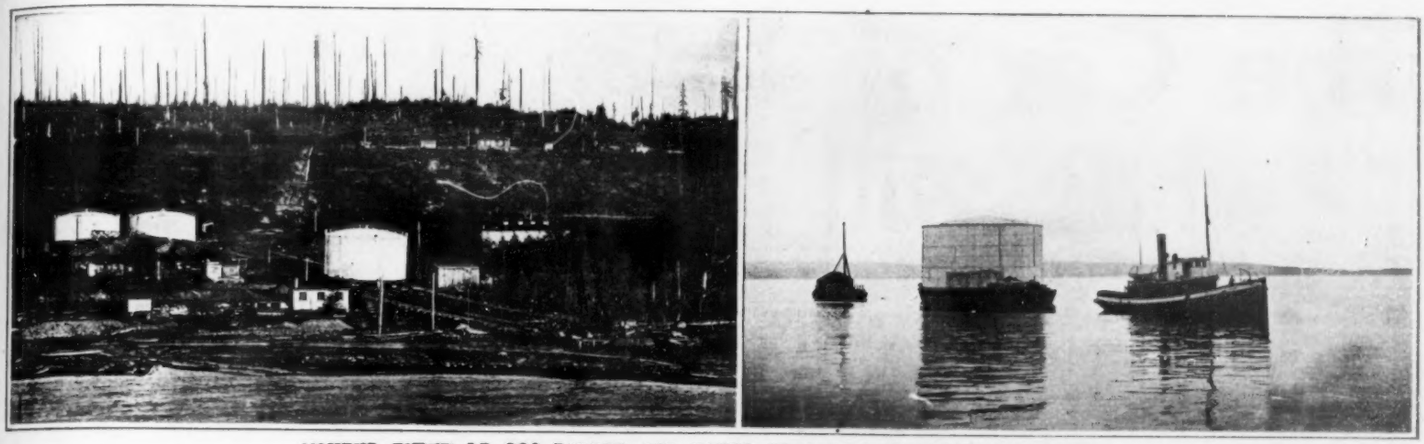
WHEN COMET AND PLANET MEET

If a comet happens to pass close to a massive body like Jupiter the planet's attraction may vastly modify the orbit of the comet and may even alter a long-period orbit or a parabolic one into an elliptic track of short period. Though in a few years planet and comet will have moved far apart, one permanent memorial of their encounter will remain; the comet's orbit will obviously pass through the point where it met the planet, and so come very close to the planet's orbit Usually when the comet returns to the danger zone the planet will be elsewhere in its orbit, and nothing will happen; but sooner or later the visitor is bound to find the planet once more in its near vicinity, and to suffer another change in its orbit, perhaps being shifted so we see it no more.

This close approach of the two orbits affords the best kind of circumstantial evidence that a comet has been captured by a planet at some time in the past. With Jupiter's family the evidence is conclusive. These comets all have periods not greatly removed from Jupiter's half-period. Their aphelia - the remotest points of their orbits from the sun - fall at distances of the same order as Jupiter's. And what is far more important, when we trace out their actual paths we find almost all of them passing very near Jupiter's orbit; half the group come within 15 million miles of it, while none of them fails to come within 60 million miles. Jupiter's responsibility for the existence of this group of comets in their present orbits is plain.

When we come to the seven comets already mentioned, with periods averaging about 70 years, it appears that this is about half Neptune's period. Again, when a plan of their orbits is drawn, their aphelia are seen to average a trifle beyond Neptune's distance from the sun. But if, instead of a picture, in which all the orbits have been forcibly shifted into one plane so that wecan draw them on our paper, we had a model, showing their true positions as they lie in space, we should then see that not one of

(Continued on page 450.)



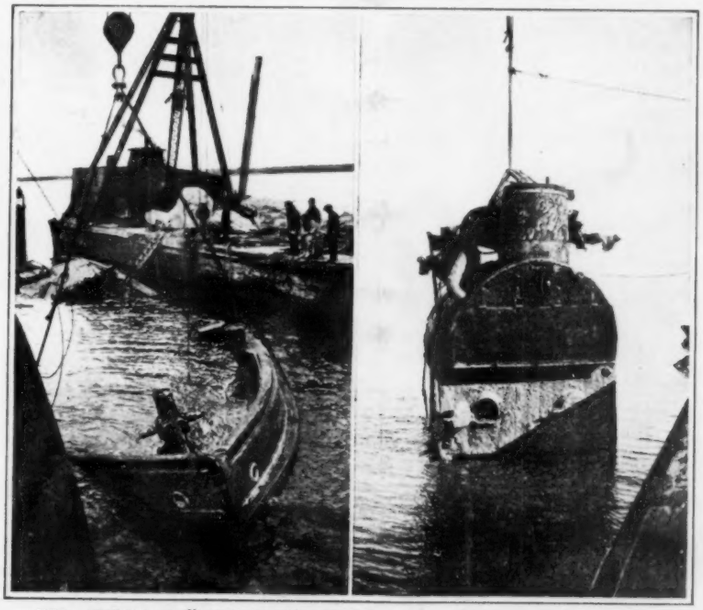
MOVING THREE 15,000-BARREL OIL TANKS TO A NEW LOCATION ON BARGES

STEEL TANKS TRANSPORTED BY WATER

It is seldom that three steel tanks 30 feet high and 60 feet in diameter have the chance to make a semi-ocean voyage without being cut down and erected again; yet this is what happened in the case of three tanks urgently needed at Powell River, B.C., for oil storage. A large paper-mill company here found that it could buy three 15,000-barrel steel storage tanks at Bamberton, B. C., at a very attractive price; but the question of getting them to Powell River safe and sound would have to get answered. It would have been extremely delicate to find men who were competent to take them apart and erect them again; and this would besides have been unduly expensive.

In this emergency, it was decided to move each of the tanks on a scow through the Straits of Georgia. Calculations were made to determine just how stable such a large body would be mounted on a scow 30 x 80 feet. The first real work came in the driving of a double line of piles at Bamberton. These were spaced so a scow could run between at the low tide and then, as the tide came up, the tank, placed on the piles in advance, would settle on the scow and the tug could take up its load. To eliminate strain, each tank was provided with a turnbuckle guy that extended from the top of the tank to a hole drilled in the tank bottom.

At Powell River four lines of piles were in readiness for the tanks. Again space was left between the rows to admit the scows. From the landing double tracks were laid to the sites where the tanks were to be put up, a distance averaging 800 feet. Standard-gage trucks were run down on the tracks, far enough to extend beneath the tank when the latter was floated in at high tide; then when the tide ebbed each tank was left loaded upon the trucks. The double-drum engine of the pile-driver was taken to haul the tanks up the inclined runways to the ready-made foundation. The full job was completed in 30 days and the company was saved $5,000 as compared to the cost of taking the tanks down and re-assembling them. Furthermore when the tanks were finally in place and tested they showed that they had stood the remarkable trip excellently, and that no leaks had resulted.



THE TUGBOAT "GENERAL" EMERGING FROM THE WATER AFTER HER LONG SOJOURN IN THE MUD, AND A VIEW OF HER BOILERS, AS THEY LOOKED WHEN BROUGHT TO THE SURFACE

SEVENTEEN FEET OF MUD

Some nine years ago the tug General sank to the bottom of Mud Lake, and she had lain there ever since, when in the winter of 1918 prevalent quotations on anything that would float were sufficiently attractive to lead to the project of salving her. This meant digging the vessel out of some 17 feet of mud through which she had sunk; and the task was further complicated by the fact that the vessel lay in 55 feet of muddy water, that became opaque at the least stir. In the face of this practically all the work had to be done by divers.

The wreck was located in the winter by soundings through the ice. Then the divers cut the boiler loose from all connections, and braced the hull.

In the spring they brought a powerful lighter equipped with two stout derricks, 60 feet high, and able to lift 60 tons each. Divers went down and passed steel-cable slings about the boiler and this was brought to the top and slung aboard the wrecking ship. With it, the tug was also relieved of a part of the house, and likewise of the funnel.

Then came the real work of passing heavy slings around the vessel itself. It was necessary here to dig holes 15 feet into the mud at the sides of the General. This was done with jets of water that tore a way through the mud. With the slings once safely in place beneath the hull by way of these holes, the weight of the wreck was counterbalanced by the salvaged boiler, plus 500 tons of rock ballast, and the hauling up begun.

Within an hour the sunken craft was but 12 feet from the surface. Then she was towed several miles, in this position, to a point where the water was clear. Divers went down and she was patched, brought to the surface, and pumped out - and incidentally 60 tons of coal were salvaged which had been in her bunkers. - G. F. Paul.

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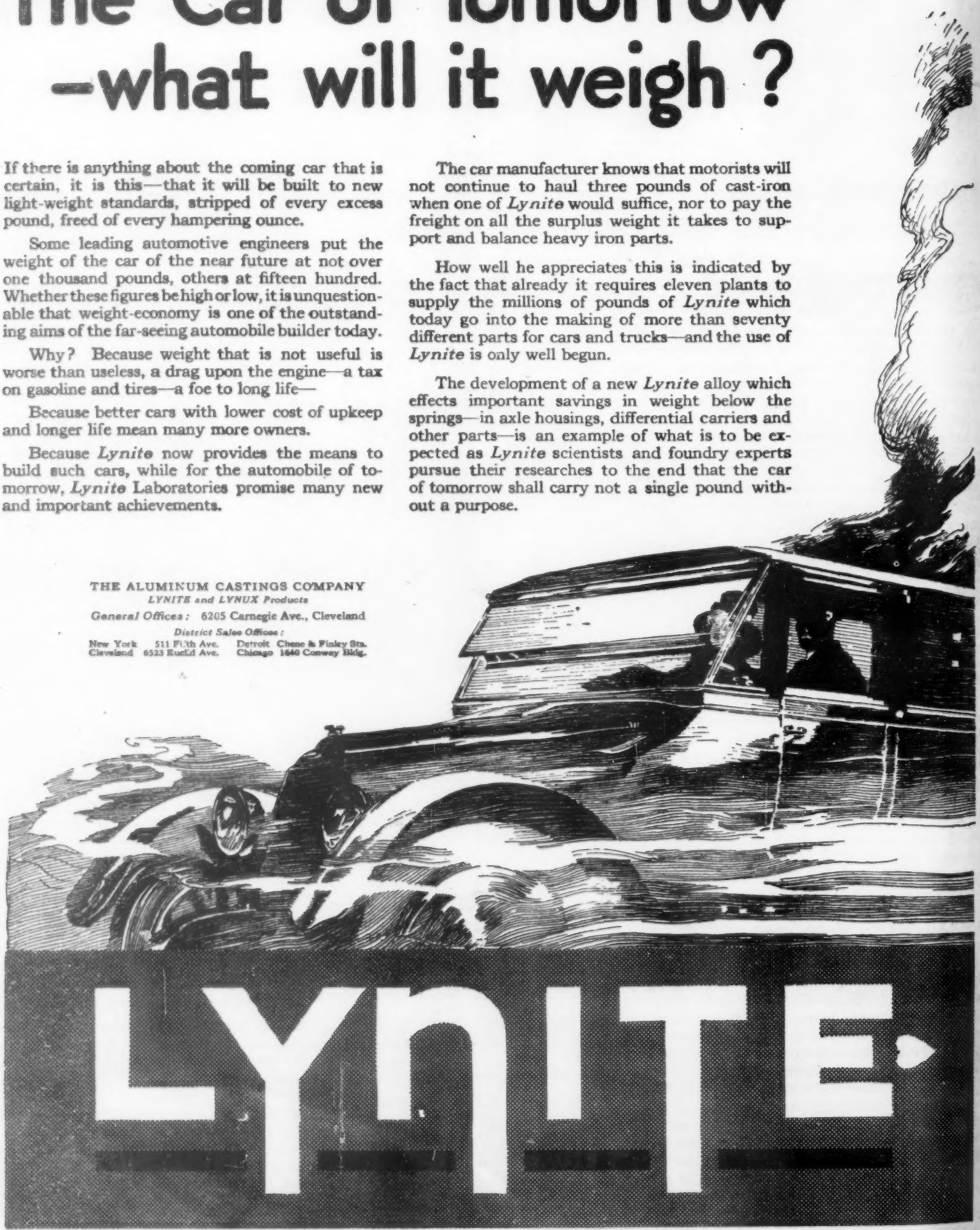

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THE ROMANCE OF INVENTION

(Continued from page 443)

between control surfaces and fuselage, between hull and wings and planes -- can, in fact, perform all manner of tests, far more accurately than can be done out on the field, in much shorter time and at vastly decreased expense, than by building the whole outfit always new and in full size. Incidentally, nobody gets killed trying something extraordinary in a wind tunnel."

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It is probably because flying has been so long a spectacular thing that the public looks upon it only as a spectacle. The stunts of an exhibition flyer and an ace

(Continued on page 451)

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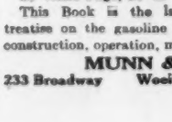

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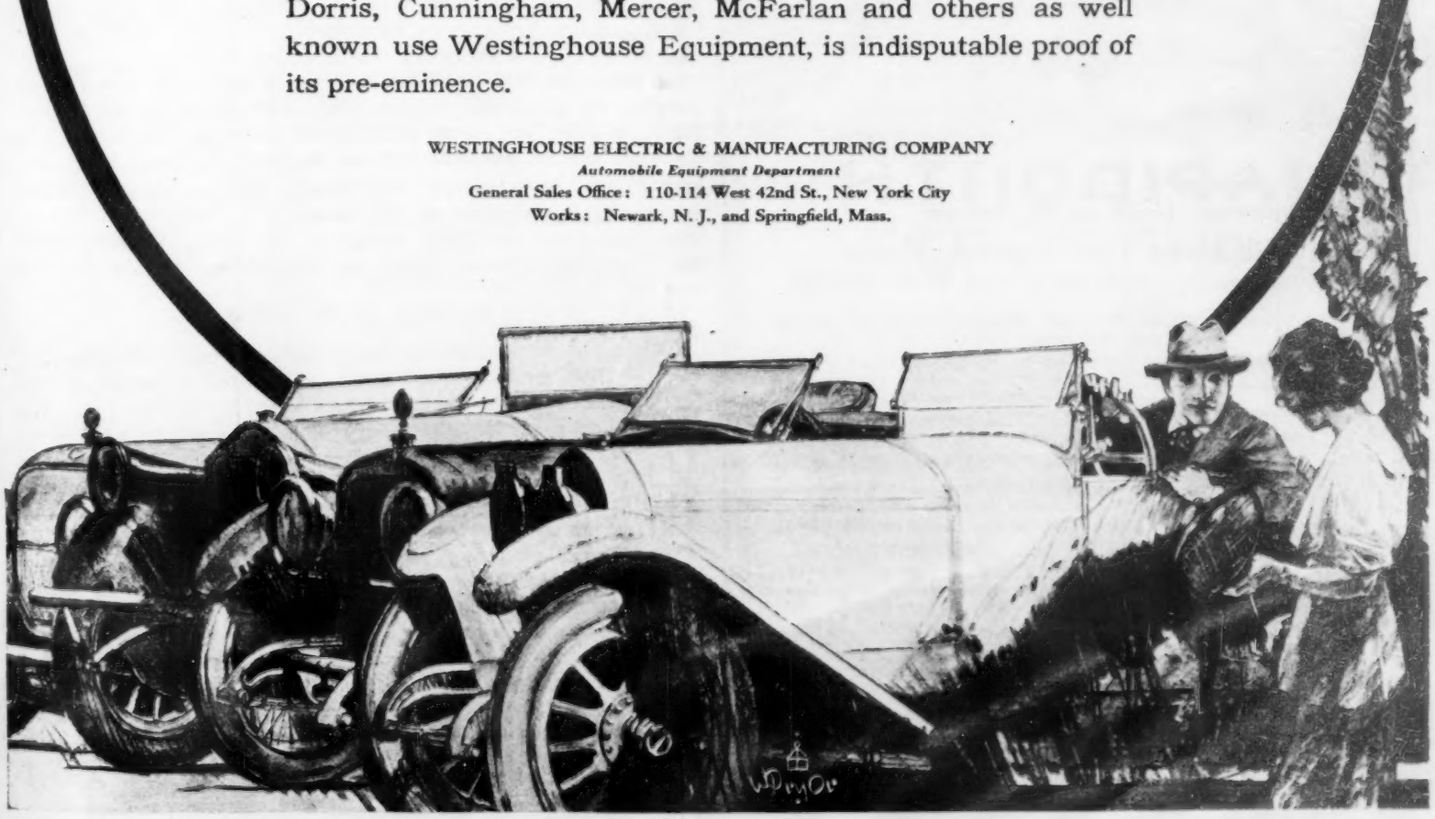

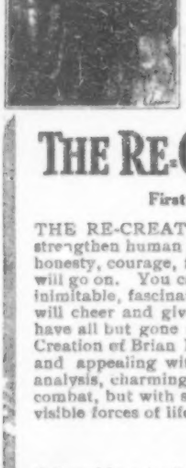

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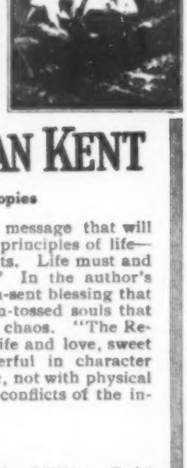

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THE HEAVENS IN NOVEMBER, 1919

(Continued from page 444)

these 7 cometary orbits comes anywhere near Neptune's path. They are all far above or below his plane; and though these comets may reach Neptune's distance from the sun the nearest possible approach to the planet by any one of them is 350 million miles. At even this distance the attraction of Neptune would be far too small to produce any great changes in a planet's orbit; while if all 7 comets should come simultaneously as close to Neptune's orbit as it is possible for them ever to be, their average distance would be more than 800 million miles. So we are forced to conclude that the alleged relation between these comets and Neptune has no foundation in fact.

THE HEAVENS

At the hour of our map, the brilliant winter constellations are beginning to show themselves again in the east. Auriga and Taurus are high in the northeast and the east; below them we find Gemini and Orion; Sirius and Procyon are still lower, having just risen. In comparison the southern sky is very dull. Eridanus, Cetus, Pisces and Aquarius have only two or three prominent stars between them; and the only really bright object in this expanse is Fomalhaut. Aries, Perseus and Andromeda are nearly overhead; Pegasus is high in the west with Cygnus and Lyra low in the northwest. Draco and Ursa Major lie along the northern horizon, with Ursa Minor above, and Cassiopeia and Cepheus higher still.

THE PLANETS

Mercury is an evening star throughout the month; he is far south and hard to find, setting before 6 P. M. Venus is a morning star, rising about 3 A. M. through the month, and exceedingly bright. Mars, too, is a morning star, rising at 1.30 A. M. in the middle of the month; Jupiter, in quadrature with the sun on the 10th, rises about 11 P. M. Saturn too is in this region of the sky between Mars and Jupiter, rising a bit after midnight. Uranus meanwhile is on the opposite side of the sun, in quadrature on the 21st, and crossing the meridian at 6 P. M., while Neptune is in Cancer, a little west of Jupiter, and observable in the morning hours.

The moon is full at 7 A. M. on the 7th, in her first quarter at 11 A. M. on the 14th, new at 10 A. M. on the 22nd, and in her first quarter at noon on the 30th. On the 8th she is nearest the earth, and farthest away on the 22nd. She passes near Uranus on the 2nd, Neptune on the 14th, Jupiter on the same date, Saturn on the 16th, Mars on the 17th, Venus on the 18th, Mercury on the 23rd, and Uranus again on the 29th.

ECLIPSES OF THE MONTH

The month is marked by two eclipses, both visible in the United States. The first, a partial eclipse of the moon, takes place early on the evening of the 7th. The moon is far north of the center of the earth's shadow, and only one-fifth of her diameter at most is immersed in it. First contact comes at 5.58 P. M., Eastern Standard Time; and the moon gets clear at 7.30. From this it is evident that the eclipse will be visible in the eastern states just after dark; further west the moon will rise eclipsed; the Pacific coast is to miss the phenomenon altogether.

Of greater interest is the annular eclipse of the sun on November 22nd. The moon comes squarely in front of the sun; but she is too far away to hide the sun completely, and for observers suitably placed she will be seen projected against the sun's disk leaving a bright

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THE HEAVENS IN NOVEMBER
(Continued from page 450)

ring visible around her rim. The annular phase will be visible along a belt about 200 miles wide, running from Texas across the gulf to Cuba and Haiti, sweeping over the Atlantic, and extending far into the Sahara.

The difference in apparent diameters is large, so the annular phase will be long in duration, 7 minutes in Texas, and 11½ off the coast of Brazil. The whole eclipse will be visible from points east of a line connecting Detroit with Tallahassee. At points west of this the sun will rise eclipsed; west of a line from Los Angeles to Butte there will be no visible eclipse, since it will be over before the sun rises The circular phase will be visible over almost all the southern half of Texas. The eclipse, though of small interest to the astronomer since the sun is not to be completely hidden, will be well worth watching as a spectacle, if clear skies on the morning of the 22nd permit.

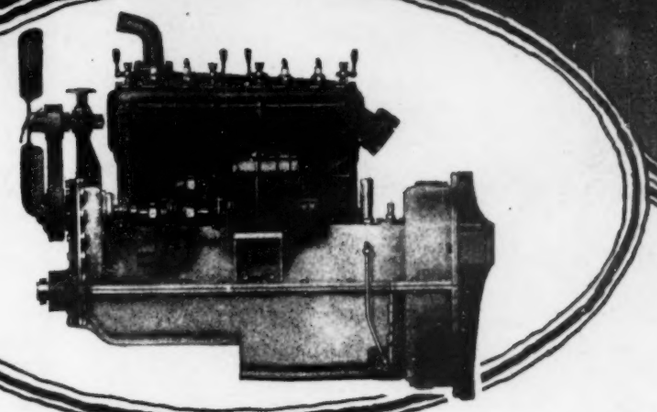
Princeton University, October 14th, 1919.

THE ROMANCE OF INVENTION
(Continued from page 448.)

have forced aerial gymnastics to the front in public knowledge of aviation. Yet here is a man and a company making machines for sober, private use, much as an automobile manufacturer makes cars. You can buy a plane as you would a car - from a catalog, and for the use you want to make of it. You can have immediate delivery. You can be taught to run it as you would be taught to run a car. But you - meaning the great public - refuse as yet to realize that the early experimental days are past and and that an airplane has arrived which may be of personal interest outside of the aerial stunts it may perform for your edification.

The one man most largely responsible for this state of affairs refuses to come up to the popular idea of the inventor. He has no longhair nor wild eyes. He is not difficult to talk to. He is modest beyond belief as to his

(Continued on page 452)



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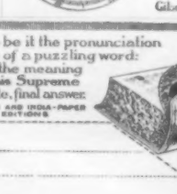

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THE ROMANCE OF INVENTION

(Continued from page 451.)

own attainments. While his best pilot, Rohlfs, was up in the heavens somewhere, trying for the altitude record, Mr. Curtiss was off at a board meeting. He reached the field in time to see the plane come down and extend his congratulations; but it might have been any ordinary test flight, for all the emotion he exhibited. At the present time he does not fly at all himself.

"I may, later," he told the present scribe, "But I will have to learn all over again. The system of control, now developed to a standard, is different from that which I used to use. What was efficient for the small, light planes would be dangerous on the present mechanisms. Oh, yes, we try to have our machines light, but the tendency is always toward more weight. For one thing, we no longer are obliged to cut down weight at the expense of safety."

Naturally the opinions of a pioneer in the flying game, who has demonstrated that he can design and invent and that his ideas could succeed commercially, are of extreme interest and value. Mr. Curtiss believes the future of flying lies in education. He thinks that the more people know about flying and the more they realize its possibilities, the sooner commercial demand will catch up to existing war-created facilities for manufacture. He regards the next year or two as the crucial ones in America's aviation development, simply because the war created large aircraft-making establishments and its end leaves these huge plants and their trained workmen little to do.

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